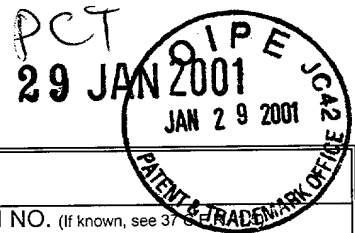


01-31-01
526 Rec'd PCT/PTO



FORM PTO-1390
(REV. 5-93)

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

CASE NO. 56/346

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known, see 37)

09/744871

INTERNATIONAL APPLICATION NO.
PCT/EP 99/04972

INTERNATIONAL FILING DATE
July 14, 1999

PRIORITY DATE CLAIMED
July 29, 1998

TITLE OF INVENTION
OPTOELECTRONIC TRANSCEIVER

APPLICANT(S) FOR DO/EO/US
Christian Eisenberger, Herbert Pronold, Peter Speckbacher

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371
2. ☐ This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)) and/or amendments under Article 34.

Items 11. to 16. Below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:

1037 Rec'd 1/15/01 29 JAN 2001

U.S. APPLICATION NO. 097744871		INTERNATIONAL APPLICATION NO. PCT/EP 99/04972		CASE NO. 56/346	
17. <input checked="" type="checkbox"/> The following fees are submitted: Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO \$860.00 International preliminary examination fee paid to USPTO (37 CFR 1.492(2)(1)) \$690.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.492(a)(2)) \$710.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.492(a)(3)) paid to USPTO \$1,000.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 <div style="text-align: center; font-weight: bold; font-size: 1.2em;">ENTER APPROPRIATE BASIC FEE AMOUNT</div>				CALCULATIONS	PTO USE ONLY
				\$860.00	
				\$130.00	
				Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	
Claims	Number Filed	Number Extra	Rate		
Total Claims	25 - 20 =	5	x \$ 18.00		\$90.00
Independent Claims	2 - 3 =	0	x \$ 80.00		\$0.00
Multiple dependent claim(s) if Applicable				0	+ \$270.00
TOTAL OF ABOVE CALCULATIONS =					\$1,080.00
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28)					
SUBTOTAL =					\$1,080.00
Surcharge of \$130.00 for furnishing the English translation later than the <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).					\$
TOTAL NATIONAL FEE =					\$1,080.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31), \$40.00 per property +					
TOTAL FEES ENCLOSED =					\$1,080.00
				Amount to be refunded	\$
				charged	\$
a. <input checked="" type="checkbox"/> A check in the amount of <u>\$1,080.00</u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. 23-1925 in the amount of \$ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 23-1925. A duplicate copy of this sheet is enclosed.					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.					
Send All Correspondence to: Brinks Hofer Gilson & Lione P.O. Box 10395 Chicago, IL 60610					
			Signature		
			Name		
			John C. Freeman		
			Registration Number: 34,483		

"Express Mail" mailing label number: EL424751739US

Date of Deposit: January 29, 2001

PATENT
CASE NO. 56/346

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application:)
Christian Eisenberger et al.)
Group Art Unit: unassigned)
International Patent Application)
No. PCT/EP99/04972)
International Filing)
Date: July 14, 1999)
U.S. Patent Application)
Serial No.: unassigned)
Filed: January 29, 2001)
Examiner: unassigned)
For: OPTOELECTRONIC TRANSCEIVER)

PRELIMINARY AMENDMENT

The Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

This Preliminary Amendment is being presented to better describe Applicants' claimed invention and it is believed does not present any new matter. Please amend the specification and the claims as follows:

In the Specification:

On page 1, after the title and before line 2, insert the new paragraph as

follows:

--Applicants claim, under 35 U.S.C. § 119, the benefit of priority of the filing date of July 29, 1998 of a German patent application, copy attached, Serial Number 198 34 090.7, filed on the aforementioned date, the entire contents of which is incorporated herein by reference. --

After the insertion of the above new paragraph, please insert in order on two separate lines the phrases --Background of the Invention-- and --Field of the Invention--;

, between lines 5 and 6, insert the phrase --Description of the Related Art--;

, line 20, delete “which is the basis for defining”; and

, line 21, delete “the preamble to claim 1 in the set of claims hereinafter.”

On page 2, line 1, insert a comma after “Thus”;

, between lines 24 and 25, insert the phrase --Summary of the Invention--;

, line 25, replace “The” with --An advantage and--;

, line 26, delete “means of”; and

, line 30, replace “result” with --results--.

On page 3, line 1, after “This” insert --advantage and--;

, lines 1 and 2, replace the phrase “the characteristics of the body of claim 1” with -- an optoelectronic transmitting unit disposed along an optical axis and having a radiation-emitting layer region and an active radiation-sensitive layer region. The optoelectronic transceiver further including an optoelectronic receiving unit disposed along the optical axis and is disposed in bridge-like fashion above the

optoelectronic transmitting unit. The optoelectronic receiving unit having an active radiation-sensitive layer region disposed perpendicular to the optical axis and located in a thin membrane, which is disposed immediately in front of the radiation-emitting layer region of the optoelectronic transmitting unit, and a radiation-emitting layer region.- -;

, delete lines 3-5 in their entirety; and

, lines 6 and 11, insert - -present- - before “invention.”

On page 4, line 1, replace “named” with - -identified- -;

, lines 2 and 10, insert - -present- - before “invention”;

, line 9, insert - -objects,- - after “Further”;

, between lines 11 and 12, insert the phrase - -Brief Description of the Drawings- -;

, line 12, replace “Fig.” with - -FIG.- - and replace “of the” with - -of an- -;

, line 13, insert - -present- - before “invention”;

, line 14, replace “Fig.” with - -FIG.- - and replace “the” with - -an- -;

, line 15, replace “of” with - -according to- - and insert - -present- - before “invention”;

, line 16, replace “Fig.” with - -FIG.- - and replace “the” with - -an- -;

, line 17, replace “of” with - -according to- - and insert - -present- - before “invention”;

, line 18, replace “Figs.” with - -FIGS.- - and replace “the” with - -an- -;

, line 19, replace “of” with - -according to- - and insert - -present - -
before “invention”;

, line 20, replace “Fig.” with - -FIG.- - and replace “the” with - -an- -;

, line 21, replace “of” with - -according to- - and insert - -present- -
before “invention”;

, line 22, replace “Fig.” with - -FIG.- - and replace “the” with - -an- -;

, line 23, replace “of” with - -according to- - and insert - -present- -
before “invention”;

, between lines 23 and 24, insert on a separate line the phrase

- -Description of the Preferred Embodiment(s)- -;

, line 24, replace “Fig. ” with - -FIG. - - and replace “the” with

- -an- -;

, line 25, insert - -present- - before “invention”;

, line 27, delete “essential”; and

, line 31, replace “Fig.” with - -FIG.- -.

On page 5, line 6, replace “comprising” with - -including- -; and

, line 22, insert a comma after “Thus.”

On page 6, line 8, insert - -present- - before “invention”

, line 9, replace the comma with - -see- -;

, line 10, replace “is” with - -the entire contents of which are- - and
after the period insert the sentence - -WO 96/36999 corresponds to U.S. Patent No.

5,852,322, the entire contents of which are incorporated herein by reference.- -; and

, lines 13 and 14, replace “4” with - -3- -.

On page 7, line 2, replace “has also been” with - -is- -;

, line 28, insert a comma after “Thus”; and

, line 29, insert - -present- - before “invention”; and
, line 30, replace “2” with - -3- -.

On page 8, line 9, insert - -present- - before “invention”;

, line 10, replace “2” with - -3- -; and

, lines 19 and 26, replace “Fig.” with - -FIG.- -

On page 9, lines 5, 16 and 20, insert - -present- - before “invention”;

, lines 6 and 20, replace “Fig.” with - -FIG.- -; and

, lines 11 and 25, insert a comma after “Thus”;

On page 10, lines 1, 2 and 4, replace “204” with - -203- -; and

, line 2, replace “2013a” with - -213a- -;

, line 13, insert - -present- - before “invention”;

, line 14, replace “Figs.” with - -FIGS.- -;

, line 17, insert a comma after “Thus”; and

, line 28, replace the first occurrence of “is” with - -are- -.

On page 11, line 9, insert - -present- - before “invention”;

, line 10, replace “Fig.” with - -FIG.- -;

, line 16, replace “42b” with - -421b- -;

, line 27, insert - -on the other hand- - before “on”; and

, line 30, delete “means of.”

On page 12, line 8, insert - -present- - before “invention”;

, lines 9 and 26, replace “Fig.” with - -FIG.- -;

, line 11, replace “comprises” with - -includes- -; and

, line 27, replace “comprising” with - -including- -.

On page 13, after line 3, insert the following new paragraph:

- -The invention may be embodied in other forms than those specifically disclosed herein without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive, and the scope of the invention is commensurate with the appended claims rather than the foregoing description.- -

On page 14 replace the word "Claims" before line 1 with the phrase - -We Claim:- -.

After page 16, insert a new page 17 that reads as follows:

- - Abstract of the Disclosure

An optoelectronic transceiver including an optoelectronic transmitting unit disposed along an optical axis and having a radiation-emitting layer region and an active radiation-sensitive layer region. The optoelectronic transceiver further including an optoelectronic receiving unit disposed along the optical axis and is disposed in bridge-like fashion above the optoelectronic transmitting unit. The optoelectronic receiving unit having an active radiation-sensitive layer region disposed perpendicular to the optical axis and located in a thin membrane, which is disposed immediately in front of the radiation-emitting layer region of the optoelectronic transmitting unit, and a radiation-emitting layer region.- -

In The Claims:

Please cancel claims 1-13 without prejudice and add claims 14-38 as follows:

14. An optoelectronic transceiver, comprising:

an optoelectronic transmitting unit disposed along an optical axis, said
optoelectronic transmitting unit comprising:

a radiation-emitting layer region; and

an active radiation-sensitive layer region; and

an optoelectronic receiving unit disposed along said optical axis and is
disposed in bridge-like fashion above said optoelectronic transmitting unit, said
optoelectronic receiving unit comprising:

an active radiation-sensitive layer region disposed
perpendicular to said optical axis and located in a thin membrane, which is disposed
immediately in front of said radiation-emitting layer region of said optoelectronic
transmitting unit; and

a radiation-emitting layer region

15. The optoelectronic transceiver of claim 14, further comprising an
optical radiation shaping element disposed between said thin membrane and said
radiation- emitting region of said optoelectronic transmitting unit.

16. The optoelectronic transceiver of claim 15, wherein said optical
radiation shaping element comprises a lens with a focusing action.

17. The optoelectronic transceiver of claim 15, wherein said optical radiation shaping element comprises an optical gel.

5 18. The optoelectronic transceiver of claim 14, further comprising:
a substrate element upon which said optoelectronic transmitting unit and said optoelectronic receiving unit are disposed, said substrate element comprising an electrical conductor track; and

an electrically conductive contacting element between said
10 optoelectronic transceiver and said electrical conductor track.

19. The optoelectronic transceiver of claim 14, wherein said active radiation-emitting layer region of said optoelectronic transmitting unit is disposed perpendicular to said optical axis.

15 20. The optoelectronic transceiver of claim 18, wherein said substrate element has a recess, and said radiation-emitting region of said optoelectronic transmitting unit and at least a portion of said active layer region of said optoelectronic receiving unit are disposed in the region of said recess, and said
20 optoelectronic transmitting unit and said optoelectronic receiving unit are disposed on two different sides of said substrate element.

21. The optoelectronic transceiver of claim 18, wherein contacting of said receiving unit, disposed above said optoelectronic transmitting unit, is effected by contacting elements which are disposed on side faces of said optoelectronic transmitting unit.

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22. The optoelectronic transceiver of claim 21, wherein said optoelectronic receiving unit as well as said optoelectronic transmitting unit are embodied as approximately of equal size in terms of surface area.

23. The optoelectronic transceiver of claim 18, wherein said optoelectronic receiving unit is disposed above said optoelectronic transmitting unit and for contacting said optoelectronic receiving unit, bond wires are disposed on said substrate element between a first contacting element and a second contacting element.

24. The optoelectronic transceiver of claim 23, wherein said optoelectronic receiving unit is embodied as smaller in surface area than said optoelectronic transmitting unit.

25. A radiation transmission system, comprising:
a waveguide that emits radiation out of an end face along an optical axis; and
an optoelectronic transceiver that receives said radiation, said optoelectronic transceiver comprising:

an optoelectronic transmitting unit disposed along an optical axis, said optoelectronic transmitting unit comprising:

a radiation-emitting layer region; and

an active radiation-sensitive layer region; and

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an optoelectronic receiving unit disposed along said optical axis and is disposed in bridge-like fashion above said optoelectronic transmitting unit, said optoelectronic receiving unit comprising:

an active radiation-sensitive layer region disposed perpendicular to said optical axis and located in a thin membrane, which is disposed immediately in front of said radiation-emitting layer region of said optoelectronic transmitting unit; and

a radiation-emitting layer region.

26. The radiation transmission system of claim 25, further comprising an optical radiation shaping element disposed between said thin membrane and said radiation- emitting region of said optoelectronic transmitting unit.

27. The radiation transmission system of claim 26, wherein said optical radiation shaping element comprises a lens with a focusing action.

28. The radiation transmission system of claim 26, wherein said optical radiation shaping element comprises an optical gel.

29. The radiation transmission system of claim 25, further comprising:
a substrate element upon which said optoelectronic transmitting unit
and said optoelectronic receiving unit are disposed, said substrate element comprising
an electrical conductor track; and
an electrically conductive contacting element between said
optoelectronic transceiver and said electrical conductor track.

30. The radiation transmission system of claim 25, wherein said radiation-sensitive area of said optoelectronic receiving unit is large when compared to said radiation-emitting portion of said end face of said optical waveguide.

31. The radiation transmission system of claim 25, wherein said active radiation-emitting layer region of said optoelectronic transmitting unit is disposed perpendicular to said optical axis.

32. The radiation transmission system of claim 25, wherein contacting of said optoelectronic transmitting unit is effected from a side that is oriented facing away from said optical waveguide.

33. The radiation transmission system of claim 29, wherein said substrate element has a recess, and said radiation-emitting region of said optoelectronic transmitting unit and at least a portion of said active layer region of said

optoelectronic receiving unit are disposed in the region of said recess, and said optoelectronic transmitting unit and said optoelectronic receiving unit are disposed on two different sides of said substrate element.

5 34. The radiation transmission system of claim 29, wherein contacting of said receiving unit, disposed above said optoelectronic transmitting unit, is effected by contacting elements which are disposed on side faces of said optoelectronic transmitting unit.

10 35. The radiation transmission system of claim 34, wherein said optoelectronic receiving unit as well as said optoelectronic transmitting unit are embodied as approximately of equal size in terms of surface area.

15 36. The radiation transmission system of claim 29, wherein said optoelectronic receiving unit is disposed above said optoelectronic transmitting unit and for contacting said optoelectronic receiving unit, bond wires are disposed on said substrate element between a first contacting element and a second contacting element.

20 37. The radiation transmission system of claim 36, wherein said optoelectronic receiving unit is embodied as smaller in surface area than said optoelectronic transmitting unit.

 38. The radiation transmission system of claim 25, wherein said end face

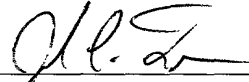
of said optical waveguide is disposed in a recess of said optoelectronic receiving unit in which said thin membrane having said active layer region is also located, and said optoelectronic transmitting unit is disposed on a side of said optoelectronic receiving unit opposite from said optical waveguide.- -

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Please note that new claims 14-38 are replacing original claims 1-13 so as to provide additional coverage for a radiation transmission system. In addition, since the original claims reflect a literal translation of the claims of the corresponding Patent

Cooperation Treaty, there is a need to stylize their language to everyday English and to use U.S. patent terminology.

Respectfully submitted,



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Dated: January 29, 2001

OPTOELECTRONIC TRANSCEIVER

The present invention relates to an optoelectronic transceiver, or transmitting and receiving unit, as generically defined by the preamble to claim 1, which is suitable in particular for bidirectional data transmission by means of optical waveguides.

For bidirectional data transmission via optical waveguides, optoelectronic transmitting units and receiving units or so-called transceivers are necessary on the various ends of the optical waveguides. One possibility for designing such transceivers is known for instance from European Patent Disclosure EP 0 410 143 A2. This reference provides that an optoelectronic transmitting unit and an optoelectronic receiving unit are disposed at an angle of 90° to one another. Via a suitable tee coupler or beam splitter element, it is assured that the radiation emitted by the transmitting unit is injected into an optical waveguide, and the radiation coming from the optical waveguide is deflected in the direction of the receiving unit. Such transceivers, however, require great effort and expense for exact adjustment or disposition of the two transmission and receiving units relative to the tee coupler and the optical waveguide. Furthermore, this arrangement always requires a suitable tee coupler; in other words, the number of components required is high.

In Japanese Patent Disclosure JP 8-179169, which is the basis for defining the preamble to claim 1 in the set of claims hereinafter, it is therefore provided that the transmitting unit and the receiving unit are disposed along a common optical axis, and this axis is identical to the optical axis of the optical waveguide. The receiving unit here is disposed adjacent to the exit face of the optical waveguide; behind or facing away from the optical waveguide, the transmitting unit follows. The tee coupler of the kind required in the arrangement in the above-cited reference, for instance, thus becomes unnecessary. The radiation emitted by the transmitting unit is injected into an SiO₂ waveguide layer on a supporting substrate, carried past the receiving unit, and injected into the optical waveguide from the waveguide layer. The reference also proposes tuning the reception and

transmission wavelengths of the two units to one another. Thus the corresponding transmitting unit emits at a wavelength at which the respective receiving unit does not respond. A problem with such an arrangement is the requisite high expense in production terms, since first the waveguide layer must be applied to the semiconductor supporting substrate, and then the semiconductor stack of transmitting units and receiving units must be applied over that. Hence complicated semiconductor production techniques are required to manufacture this component. Furthermore, in the proposed arrangement, problems arise when the radiation emitted by the transmitting unit is injected into the waveguide layer and from there into the optical waveguide. Injection losses at these locations can hardly be avoided, and thus the overall efficiency of this arrangement suffers in turn. It should also be noted that the respective active layer regions of the two semiconductor components are oriented relative to the optical axis in such a way that the optical axis is located in the plane of each of the active regions, or is oriented parallel to that. Depending on the manner of imposition on this element of the radiation that leaves the exit face of the optical waveguide, additional problems arise. For instance, in the case of direct irradiation of this element via the optical waveguide, adjustment problems arise. Then a relatively narrow surface area of the receiving element must be oriented as highly exactly as possible relative to the extraction end of the optical waveguide, which requires corresponding effort and expense in the assembly process. Conversely, if provision is made for imposition by injecting the radiation of the optical waveguide into the waveguide layer, then once again the losses and problems already discussed above occur upon injecting and extracting this radiation.

The object of the present invention is therefore to refine the optoelectronic transceiver for bidirectional data transmission by means of optical waveguides, as generically defined at the outset, in such a way that in particular still further-increased insensitivity with regard to the adjustment of the various elements relative to the optical waveguide and thus a reduced effort and expense of assembly result. Furthermore, the simplest possible production of such a device is desirable.

This object is attained by an optoelectronic transceiver having the characteristics of the body of claim 1.

Advantageous embodiments of the optoelectronic transceiver according to the invention will become apparent from the provisions recited in the dependent claims.

According to the invention, it is now provided that at least the active radiation-sensitive layer region of the receiving unit be disposed perpendicular to the axis of the receiving unit, along which the receiving unit and the transmitting unit are disposed. This axis is preferably predetermined by the optical axis of symmetry of the optical waveguide. This arrangement becomes possible in particular by the use according to the invention of special optoelectronic receiving units, in which the active layer region is located in a thin membrane through which light can be projected by the transmitting unit. Since the radiation-sensitive surface of the receiving unit is now relatively large compared with the end face or exit face of the optical waveguide, the result at least for the optoelectronic receiving unit is a suitably wide tolerance range, within which this element can be mounted, correctly adjusted, in front of the exit face of the optical waveguide.

Furthermore, the transmitting unit can also be disposed relative to the optical axis in such a way that the plane of the active light-emitting region is likewise oriented perpendicular to the optical axis. In principle, an exact alignment of this component with the optical waveguide, because of the usual projection characteristics, is not as critical, and thus this provision can be made optional.

Since furthermore provision for direct projection through the receiving unit of the radiation emitted by the transmitting unit is provided, the aforementioned problems with regard to the otherwise required waveguide layer on a supporting substrate do not occur.

There are in principle a number of possible ways for how the two transmitting and receiving units can be suitably disposed to one another and how in particular the respective transmitting and receiving units can be contacted.

A further advantage that can be named is that the required optical waveguide in the apparatus of the invention needs to be oriented only relatively coarsely relative to the optoelectronic components and fixed on a suitable housing; for this purpose, a suitable plug connector is preferably provided. By comparison, the variants in the prior art require a separate module housing, out of which the optical waveguide, adjusted with high precision, must be extended outward in the form of a so-called pigtail, which in turn must be connected to a downstream optical waveguide via suitable coupling elements.

Further advantages and details of the optoelectronic transceiver according to the invention will become apparent from the ensuing description of various exemplary embodiments in conjunction with the accompanying figures.

Fig. 1 is a schematic view of a first exemplary embodiment of the optoelectronic transceiver according to the invention;

Fig. 2 schematically shows a second embodiment of the optoelectronic transceiver of the invention;

Fig. 3 schematically shows a third embodiment of the optoelectronic transceiver of the invention;

Figs. 4a and 4b show various views of a fourth embodiment of the optoelectronic transceiver of the invention;

Fig. 5 schematically shows a fifth embodiment of the optoelectronic transceiver of the invention;

Fig. 6 schematically shows a sixth embodiment of the optoelectronic transceiver of the invention.

From the schematic illustration in Fig. 1, a first embodiment of the optoelectronic transceiver according to the invention will now be described.

A substrate element 2, embodied for instance as a printed circuit board, is disposed in a suitable housing 1. The essential elements of the present invention are disposed on the substrate element 2, and besides performing mechanical supporting and stabilizing functions, the substrate element 2 also serves to contact the optoelectronic components disposed on it. To that end, suitable conductor tracks, not visible in Fig. 1, however, are provided in the substrate element 2. As

the essential components relative to the function of the optoelectronic transceiver according to the invention, a transmitting unit 3 and a receiving unit 4 are provided on the substrate element 2; they are oriented at a certain spatial relative orientation to an optical waveguide 5, or to its end face 6 that faces toward the optoelectronic transceiver. In this exemplary embodiment, the optical waveguide 5 has a two-part structure, comprising an optical waveguide core and an optical waveguide sheath. The end face 6 of the optical waveguide is held by suitable structural provisions in a fixed relative orientation to the transmitting unit and receiving unit 3, 4. Various options can be considered for this purpose, such as suitable plug connectors, etc. It is understood that various options also exist with regard to the structure of whatever optical waveguide is used.

Both the transmitting unit 3 and the receiving unit 4 are disposed adjacent along a common axis 12, which in the exemplary embodiment shown is defined by the optical axis of symmetry of the optical waveguide 5. Because of this arrangement, there is no need for an optical tee coupler, of the kind otherwise typically required for deflecting the radiation arriving from the optical waveguide 5 to the receiving unit 4 and for deflecting and injecting the radiation, emitted by the transmitting unit 3, into the optical waveguide 5.

Furthermore, and based in particular on the choice of a particular receiving unit 4 and the corresponding arrangement thereof relative to the optical axis 12, it is assured that the relative orientation of the receiving unit 4 to the end face 6 of the optical waveguide 5 is possible with relatively wide tolerances. Thus the selected optoelectronic receiving unit 4 has a radiation-sensitive layer region 8 - merely indicated schematically - that is located in the plane of a thin membrane and is disposed perpendicular to the optical axis 12. The plane of the active layer region 8 or radiation-sensitive surface in which the signal generation occurs from the incidence of the indicated radiation, is accordingly oriented perpendicular to the plane of the drawing. The radiation-sensitive surface of the receiving unit 4, which accordingly corresponds to the surface area of the active layer region 8, is thus especially large relative to the exit face of the respective optical waveguide, or in the instance shown relative to the core region or core surface in the end face

6. The overall result of this arrangement is therefore markedly reduced effort and expense of adjustment, which pertains to the exact positioning of the receiving unit 4 relative to the radiation-emitting region of the end face 6 of the optical waveguide 5. At this location, a conventional plug connector can for instance be used, since there are no stringent demands with regard to the relative orientation of the optical waveguide 5 and the receiving unit 4 as a result.

As already noted, this is achieved primarily by the choice according to the invention of the optoelectronic receiving unit 4. For a detailed description of this component, International Patent Disclosure WO 96/36999 of the present Applicant is hereby expressly incorporated by reference.

The membrane region of the receiving unit 4 having the active radiation-sensitive layer region 8 is embodied as so thin, in one possible embodiment on the order magnitude of about 2 μm , that the transmitting unit 4 can project light through this membrane region. The transmitting unit 4 is accordingly also disposed along the optical axis 12, specifically downstream of the receiving unit 4 from the standpoint of the optical waveguide 5. In the radiation-emitting surface region of the transmitting unit 3, a beam shaping optical element 7 is provided in the exemplary embodiment shown, which can be embodied for instance as a lens with suitable optical properties.

As an alternative, it would also be possible to embody the beam shaping optical element 7 at this point with a so-called optical gel. In addition, the beam shaping optical element 7 could also be embodied as a Fresnel structure or as a grating structure on the underside of the membrane, that is, on the side of the receiving unit 4 facing toward the transmitting unit 3; this side would have to be structured to suit this purpose.

Essentially, the beam shaping optical element 7 accomplishes focusing of the radiation, emitted by the optoelectronic transmitting unit 3, onto the end face 6 of the optical waveguide 5. In the case where an optical gel is used at this point, reflections from the various boundary faces and air gaps, which would each cause a loss of efficiency, can also be avoided.

In the first exemplary embodiment shown, the geometrical dimensioning of the active radiation-sensitive surface of the receiving unit 4 has also been selected such that this surface covers the required surface of the transmitting unit on the substrate element 2. As a result, along with simple assembly of the overall arrangement, this also makes it possible to contact the various optoelectronic components on the substrate element 2.

The most various optoelectronic semiconductor components can be considered for the transmitting unit 3, such as LEDs, laser diodes, and so forth.

Since the relative adjustment of the transmitting unit 3 to the optical waveguide 5 is as a rule not so problematic, because of the typical projection characteristics, as the adjustment of (conventional) receiving units, it is not absolutely necessary within the scope of the present invention for the active radiation-emitting layer regions of the transmitting unit 3 also to be oriented perpendicular to the optical axis 12. Accordingly, transmitting units in which the active radiation-emitting layer region in the extension of the optical axis 12 is oriented parallel to it, or perpendicular to it, could accordingly be disposed along the optical axis 12.

Within the scope of the present invention, the most various combinations of transmitting and receiving wavelengths can be employed for the bidirectional data transmission.

For instance, it is possible to select the transmitting unit and receiving unit 3, 4, and thus the corresponding transmitting and receiving wavelengths λ_S , λ_E , such that as much as possible they do not affect the respective other unit. Depending on the semiconductor materials used in the two optoelectronic components, the emitted wavelength λ_S of the transmitting unit 3 varies, or the response characteristic of the receiving unit 4 and thus its wavelength λ_E varies with maximum response sensitivity.

Thus in one possible embodiment of the apparatus according to the invention, it can be provided that if at all possible the emitted wavelength λ_S of the transmitting unit 2 does not coincide with the wavelength λ_E at which the receiving unit 4 primarily responds. In the case of such a choice of the respective

wavelengths λ_S , λ_E , so-called full duplex operation of the optoelectronic transceiver of the invention would be possible, that is, the simultaneous transmission and reception of data via the coupled optical waveguide 5.

Alternatively, however, it is also possible for the respective wavelengths λ_S , λ_E or wavelength ranges not to be tuned in such a way to one another, and by suitable timed triggering of the two semiconductor components 3, 4 to assure that in the course of signal transmission, either only transmission or only reception will be done. This would then correspond to a so-called half duplex mode of the optoelectronic transceiver according to the invention.

In one possible embodiment in the half duplex mode, a transmitting unit 2 would for instance be provided for which $\lambda_S = 850$ nm. The maximum sensitivity of the receiving unit 4 is then in the same wavelength range, that is, $\lambda_E = 850$ nm. In that case, the thickness of the radiation- sensitive layer region in the receiving unit 4 would be selected as approximately 2 μm , which in the membrane region would result in a transmission factor of 50% at the selected wavelengths λ_S , $\lambda_E = 850$ nm.

With regard to the optoelectronic transceivers 3, 4, many optional choices are thus available within the scope of the present invention.

In the exemplary embodiment of Fig. 1, the contacting of the transmitting unit and receiving unit 3, 4 always takes place from the back side of the respective units. The back side is understood to mean that side oriented facing away from the optical waveguide 5. Thus schematic contacting elements 13a, 13b are shown in suggested form on the back side of the transmitting unit 3, and by way of them the transmitting unit 3 is connected to conductor tracks in the substrate element 2 and thus is connected to a downstream triggering and evaluation unit, also not shown in Fig. 1. Also on its back side, the receiving unit 4 has contacting elements 9a, 9b, which are connected in turn to electrically conductive spacers 10a, 10b. On the opposite end, the spacers 10a, 10b are connected via further contacting elements 11a, 11b also to conductor tracks in the substrate element 2, by way of which the electrical connection of the receiving unit to the aforementioned triggering and evaluation unit is made.

Contacting of the two semiconductor components 3, 4 in this way proves to be advantageous in the sense that the components can be mounted on the substrate element 2 or circuit board relatively simply, employing known surface mounting device (SMD) assembly methods.

5 An alternative second embodiment of the apparatus of the invention is shown schematically in Fig. 2. It is essentially distinguished only in the manner of electrical contacting of the transmitting unit and receiving unit 103, 104 disposed on the substrate element 102 in the housing 101. While once again the contacting of the transmitting unit 103 is effected with the aid of the contacting elements 10
113a, 113b disposed on the back side, an alternative contacting variant is intended only for the receiving unit 104. Thus the receiving unit 104 is secured to the substrate element 102 via insulating elements 116a, 116b, while the contacting is done via bond wires 115a, 115b, which are disposed in the case of the receiving unit 104 on the side that faces counter to the radiation to be detected, or in other words its front side.

15 Otherwise, this embodiment of the apparatus of the invention again corresponds to the preceding variant in terms of the relative disposition of the various elements with regard to the axis 112, and so forth.

20 A third embodiment of the optoelectronic transceiver according to the invention is schematically shown in Fig. 3. Once again, this exemplary embodiment is distinguished from the preceding variants primarily in the selected manner of contacting the transmitting unit and receiving unit 203, 204, and merely offers certain advantages with regard to the possibly fully automatic SMD assembly.

25 Thus a substrate element 203 is now provided in the housing 201, and this element has an opening or recess 220 in a portion of it. Both the transmitting unit 203 and the receiving unit 204 are disposed in the region of this opening. The disposition of the transmitting unit 203 is done on the side of the substrate element 202 that is oriented facing away from the optical waveguide 205. The beam
30 shaping optical element 207, embodied as a lens, is disposed in the region of opening 220.

The contacting of the transmitting unit 204 is done via contacting elements 2013a, 2013b, which are disposed on the front side of the transmitting unit 204, that is, the side facing toward the optical waveguide 205. In this embodiment, the transmitting unit 204 is thus contacted on its front side.

5 The optoelectronic receiving unit 204, conversely, is again contacted and connected to the substrate element 202 from the side oriented facing away from the optical waveguide 205 or its end face 206. To that end, suitable contacting elements 2016a, 2016b are provided between the back side of the receiving unit 204 and the substrate element 202 and the conductor tracks disposed therein.

10 Otherwise, this exemplary embodiment again corresponds with regard to the disposition of the various components and so forth to the variants already described above.

A fourth embodiment of the optoelectronic transceiver of the invention is shown in Figs. 4a and 4b in various views. The essential distinctions from the variants described above are again to be seen in terms of the manner of contacting the transmitting unit and receiving unit 303, 304.

15 Thus the disposition of the transmitting unit 303 is done on a substrate element 302, and for contacting this element 302, rectangular contacting elements 320a, 320b are provided, both on the transmitting unit 303 and on the substrate element 302. Via a conductive contacting material 319b, such as a suitable solder, disposed between them, the conductive connection with conductor tracks in the substrate element 302 is made. The contacting regions 320a, 320b are disposed here on opposite sides of the transmitting unit 303. 90° away from them is a further pair of contacting elements 309a, 309b for the receiving unit 304, and between these elements, there is once again a conductive contacting material 310a, 20 310b. These contacting elements 309a, 309b accordingly serve to contact the receiving unit 304 disposed above the transmitting unit 303. A total of three contacting elements 309a, 309b is disposed on each side, that is, one each on the underside of the receiving unit 304, on the side face of the transmitting unit 303, 25 and on the substrate element 302. In order to prevent the contacting elements 309a, 309b, in particular, that are disposed on the side faces of the transmitting

30

unit 303 from coming into contact with the transmitting unit 303, U-shaped separation elements 315a, 315b are provided, claspings this region, on the corresponding side faces of the transmitting unit 303.

As to the rest of the basic design, such as the disposition of the radiation-sensitive layer region 308 in the receiving unit 304, this exemplary embodiment again corresponds to the variants described above. It is understood that once again a suitable beam shaping optical element can be provided between the transmitting unit 303 and the receiving unit 304, and so forth.

A fifth variant of the optoelectronic transceiver of the invention is schematically shown in Fig. 5. Below, only the special manner of contacting the various components will be addressed; the fundamental design is identical to that of the preceding embodiments.

In this case, a transmitting unit 403 is now disposed on a substrate element 402, whose total area is greater than that of the receiving unit 404 disposed above it. Because of this arrangement, the contacting of the receiving unit 404 is possible via bond wires 421a, 42b, which connect various contacting elements 409a, 409b to one another. Here the contacting elements 409a, 409b are disposed on the underside of the receiving unit 404, on portions of the top side of the transmitting unit 403, and on the substrate element 402. Via the bond wires 421a, 421b, a conductive connection is established between the contacting elements on the top side of the transmitting unit 403 and those on the substrate element 402. Once again, an electrically conductive contacting material 410a, 410b is provided between the contacting elements 409a, 409b on the underside of the receiving unit and the contacting elements 409a, 409b disposed on the top side of the transmitting unit 403. The contacting of the transmitting unit 403 is done via contacting elements 420a, 420b, which on the one hand are disposed on the underside of the transmitting unit 403 and on the substrate element 402; between each of them, a conductive contacting material 419a, 419b is provided.

While in all the previous exemplary embodiments the contacting of the receiving unit has been made by means of a suitable geometrical embodiment and/or disposition of the two units and by a suitable disposition of various

contacting elements, and so forth, a fundamentally alternative embodiment for this purpose would also be possible. For instance, suitable bores or narrow holes could be made in peripheral regions of the transmitting unit and filled with conductive contacting material, thus enabling the receiving unit, located at the top, to be contacted through the transmitting unit. The bores or holes required for this purpose could be made by a so-called thermomigration method or by drilling using lasers.

A sixth embodiment of the apparatus of the invention will now be described in closing, in conjunction with a fragmentary view in Fig. 6.

All that is shown here is the arrangement, located in a housing 601, that comprises a transmitting unit 603, receiving unit 604 and optical waveguide 605. The optical waveguide 605, or its end face 606, is now disposed directly in a recess of the receiving unit 604. The recess is provided here in a region of the receiving unit 604 in which the membrane-like portion of the receiving unit 604, in which the active layer region 608 is disposed, is also located. The transmitting unit 603 is disposed above the membrane having the active layer region 608. The radiation-emitting face of the transmitting unit 603 is oriented in the direction of the recess or the end face 606 of the optical waveguide 605. Contacting of the transmitting unit 603 is done with the aid of contacting elements - not shown - that are disposed between the light-emitting side of the transmitting unit 603 and the receiving unit. The contacting elements - also not shown - of the receiving unit 604 can for instance be disposed beside them, that is, on the top side of the receiving unit 604.

The contacting elements of the two optoelectronic components 603, 604 are then also connected to the corresponding contacting elements on a substrate element in the housing, also not shown in Fig. 6.

A fixation of the entire arrangement comprising the optical waveguide 605 and two units 603, 604 could be done for instance by adhesive bonding or by encapsulation.

As has become clear from the preceding description of several exemplary embodiments, a number of possibilities thus exist for advantageously embodying

the present invention. It is understood that the provisions explained in conjunction with the various exemplary embodiments can also be suitably combined, in the final analysis resulting in manifold options for realizing the present invention.

100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

Claims

1. An optoelectronic transceiver for bidirectional data transmission by means of optical waveguides, comprising an optoelectronic transmitting unit and an optoelectronic receiving unit, both of which each have at least one active radiation-sensitive layer region or radiation-emitting layer region, and the transmitting unit and receiving unit are disposed along an optical axis,

characterized in that

at least the active radiation-sensitive layer region (8; 108; 208; 308; 408; 608) of the receiving unit (4; 104; 204; 304; 404; 604) is disposed perpendicular to the optical axis (12; 112; 212; 312; 412).

2. The optoelectronic transceiver of claim 1, characterized in that the active layer region (8; 108; 208; 308; 408; 608) of the receiving unit (4; 104; 204; 304; 404; 604) is located in a thin membrane, which is disposed immediately in front of the light-emitting region of the transmitting unit (3; 103; 203; 303; 403; 603) and in this way at least a portion of the emitted radiation passes through the membrane in the direction of the optical waveguide (5; 105; 205; 305; 405; 605).

3. The optoelectronic transceiver of claim 2, characterized in that an optical radiation shaping element (7; 107; 207) is disposed between the membrane and the light-emitting region of the transmitting unit (3; 103; 203).

4. The optoelectronic transceiver of claim 3, characterized in that the optical beam shaping element (7; 107; 207) is embodied as a lens with a focusing action.

5. The optoelectronic transceiver of claim 3, characterized in that the optical beam shaping element (7; 107; 207) is formed from an optical gel.

6. The optoelectronic transceiver of claim 1, characterized in that the transmitting unit and receiving unit are disposed on a substrate element (2; 102; 202; 302; 402), and furthermore electrically conductive contacting elements (9a, 9b, 11a, 11b, 13a, 13b; 113a, 113b, 115a, 115b; 216a, 216b, 213a, 213b; 309a, 309b, 320a, 320b) are present between the transceiver on the one hand and electrical conductor tracks in the substrate element (2; 102; 202; 302; 402) on the other.

7. The optoelectronic transceiver of claim 1, characterized in that the radiation-sensitive surface area of the receiving unit (4; 104; 204; 304; 404; 604) is embodied as large, compared to the radiation-emitting portion of the end face of the optical waveguide (5; 105; 205; 305; 405; 605) from which the radiation to be detected is extracted.

8. The optoelectronic transceiver of claim 1, characterized in that the active light-emitting layer region of the transmitting unit is also disposed perpendicular to the optical axis.

9. The optoelectronic transceiver of claim 1, characterized in that the receiving unit (4; 104) is disposed in bridgelike fashion above the transmitting unit (3; 103), and the contacting of the transmitting unit (3; 103) is effected from the side that is oriented facing away from the optical waveguide (5; 105).

10. The optoelectronic transceiver of claim 6, characterized in that the substrate element (202) has a recess, and the radiation-emitting region of the transmitting unit (203) and at least a portion of the active layer region (208) of the receiving unit (204) are disposed in the region of this recess, and the transmitting unit and receiving unit (203, 204) are disposed on the two different sides of the substrate element (202).

11. The optoelectronic transceiver of claim 6, characterized in that the receiving unit (304) as well as the transmitting unit (303) are embodied as approximately of equal size in terms of surface area, and the contacting of the

receiving unit (304), disposed above the transmitting unit (303), is effected by contacting elements (309a, 309b) which are disposed on the side faces of the transmitting unit (303).

5 12. The optoelectronic transceiver of claim 6, characterized in that the receiving unit (404) is embodied as smaller in surface area than the transmitting unit (303) and is disposed above it, and for contacting the receiving unit (404), bond wires are disposed on the substrate element (402) between contacting elements (409a, 409b) and contacting elements (409a, 409b).

10 13. The optoelectronic transceiver of claim 2, characterized in that the end face (606) of the optical waveguide (605) is disposed in a recess of the receiving unit (604) in which the membrane having the active layer region (608) is also located, and the transmitting unit (603) is disposed on the side of the receiving unit (604) opposite from the optical waveguide (605).

ABSTRACT OF THE DISCLOSURE

An optoelectronic transceiver including an optoelectronic transmitting unit disposed along an optical axis and having a radiation-emitting layer region and an active radiation-sensitive layer region. The optoelectronic transceiver further including an optoelectronic receiving unit disposed along the optical axis and is disposed in bridge-like fashion above the optoelectronic transmitting unit. The optoelectronic receiving unit having an active radiation-sensitive layer region disposed perpendicular to the optical axis and located in a thin membrane, which is disposed immediately in front of the radiation-emitting layer region of the optoelectronic transmitting unit, and a radiation-emitting layer region.

FIG. 1

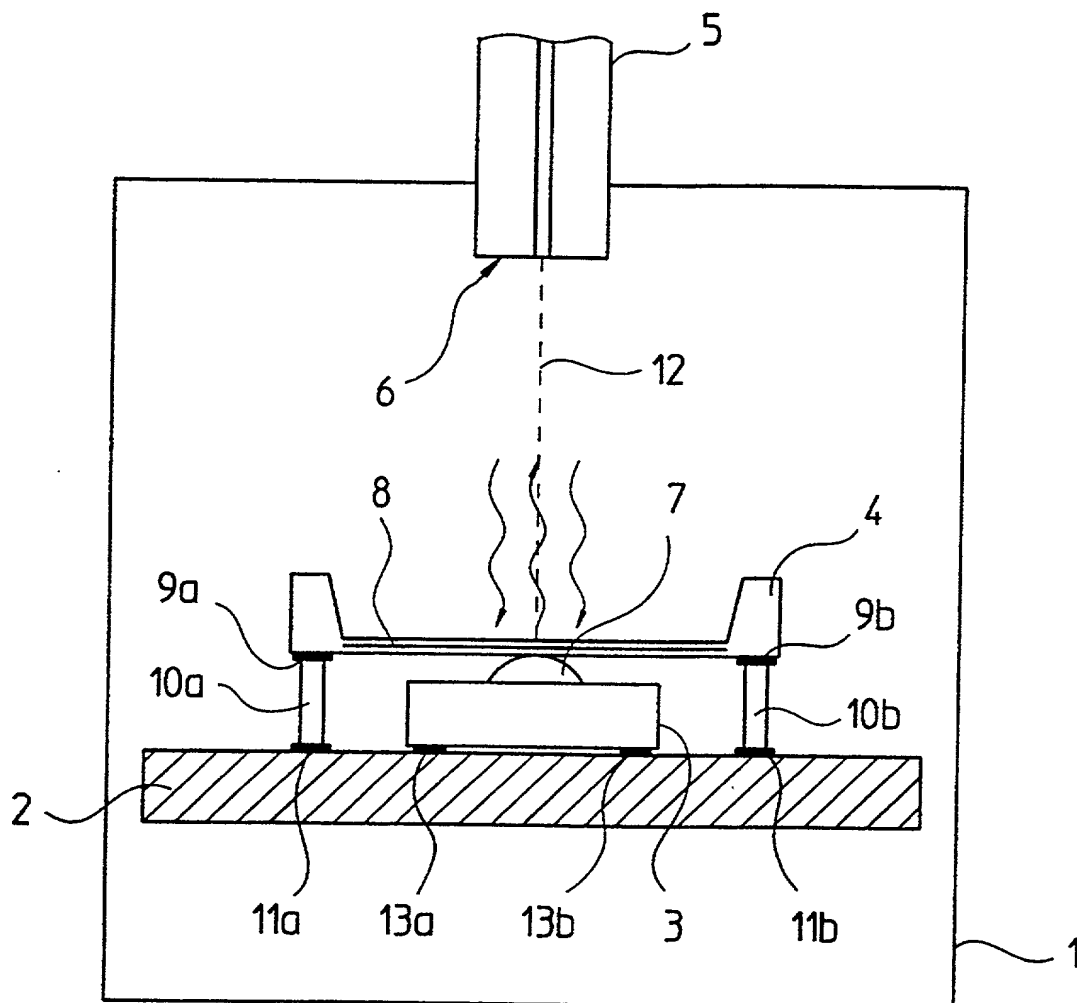


FIG. 2

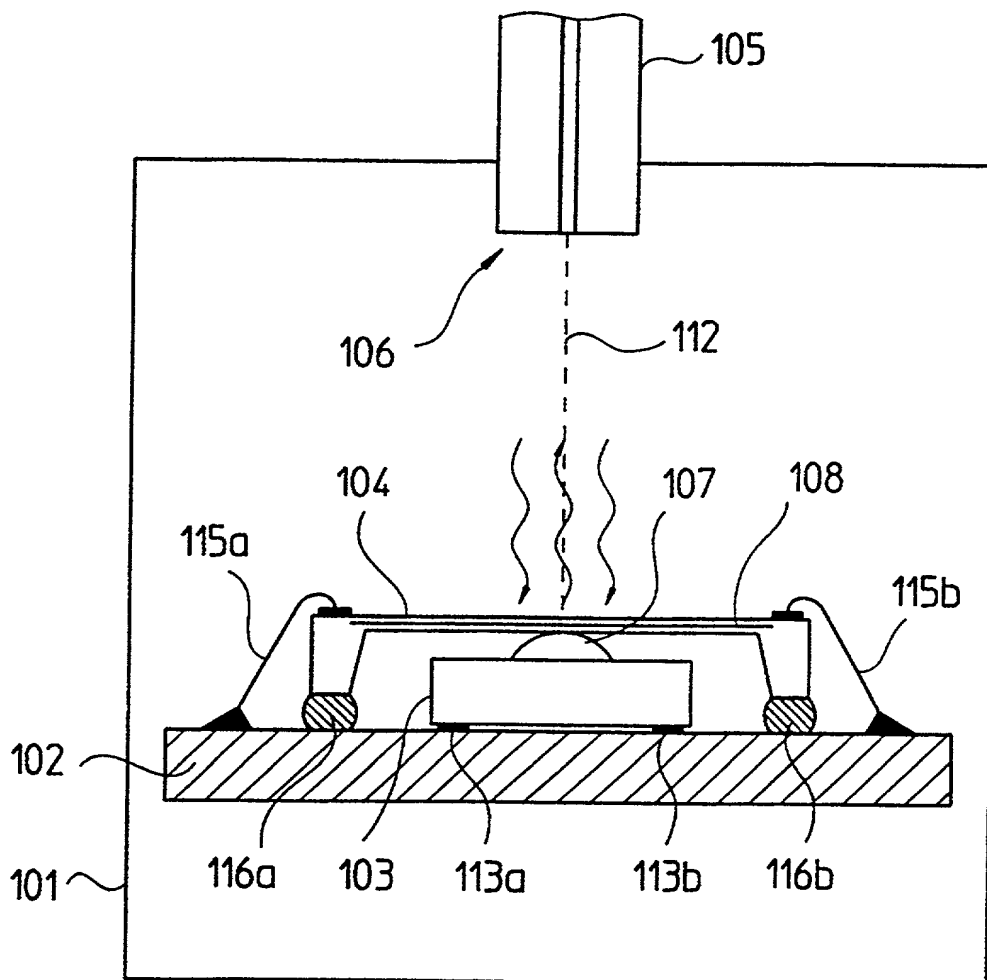


FIG. 3

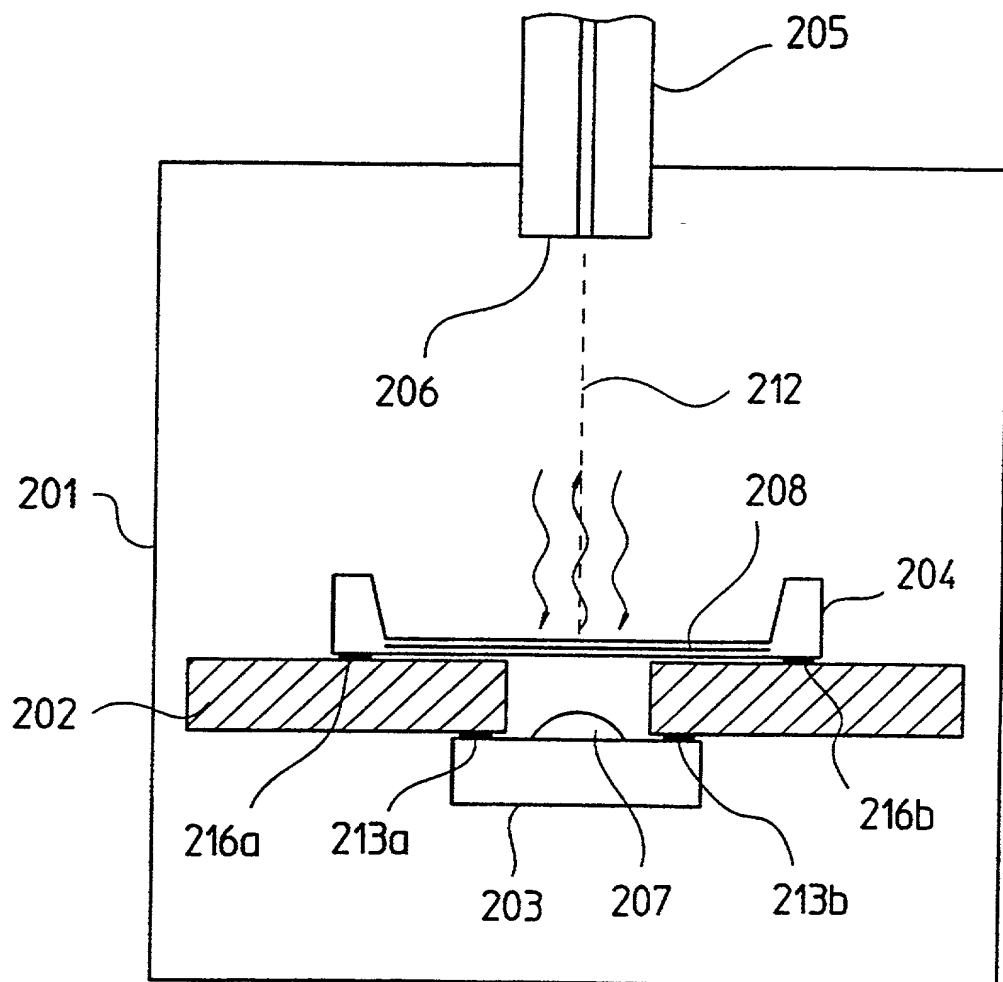


FIG. 4a

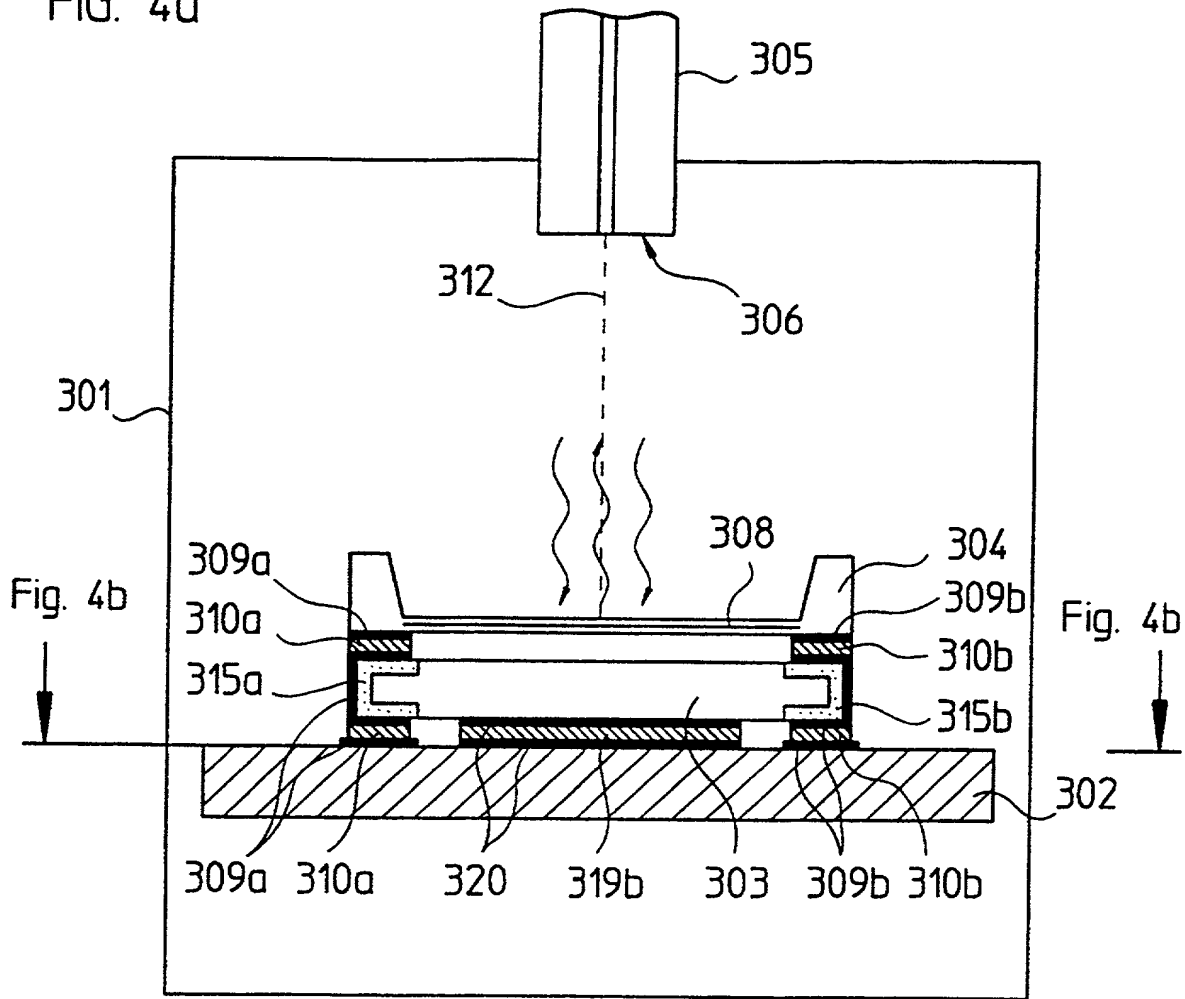


FIG. 4b

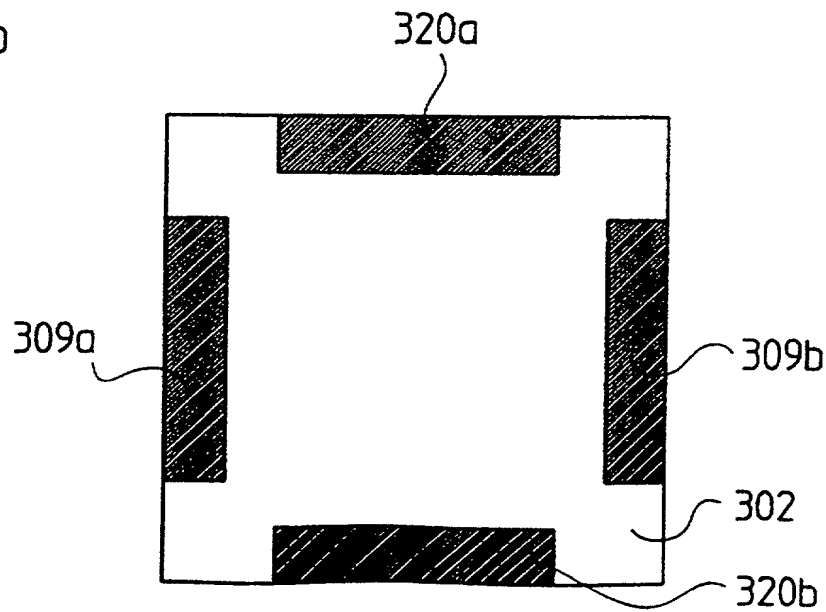


FIG. 5

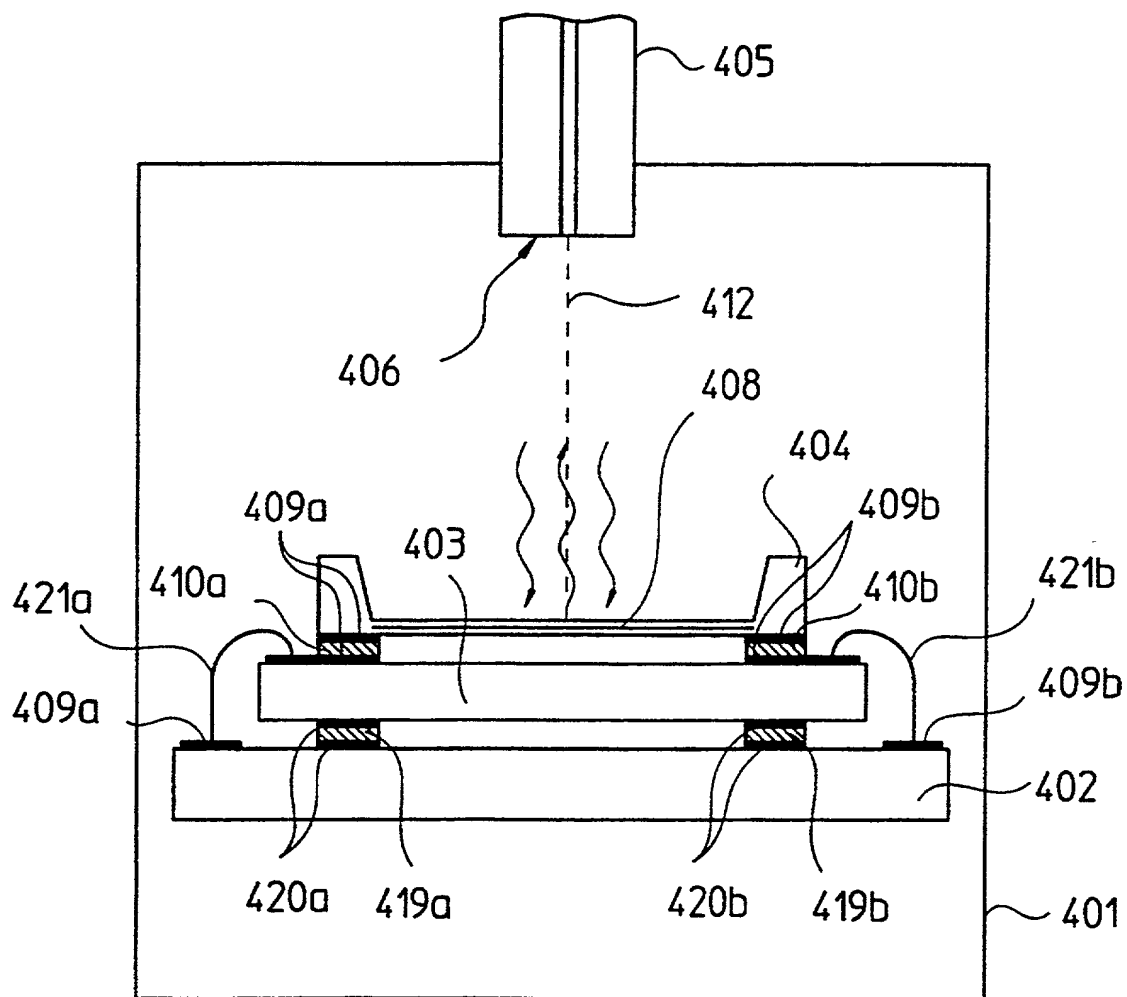
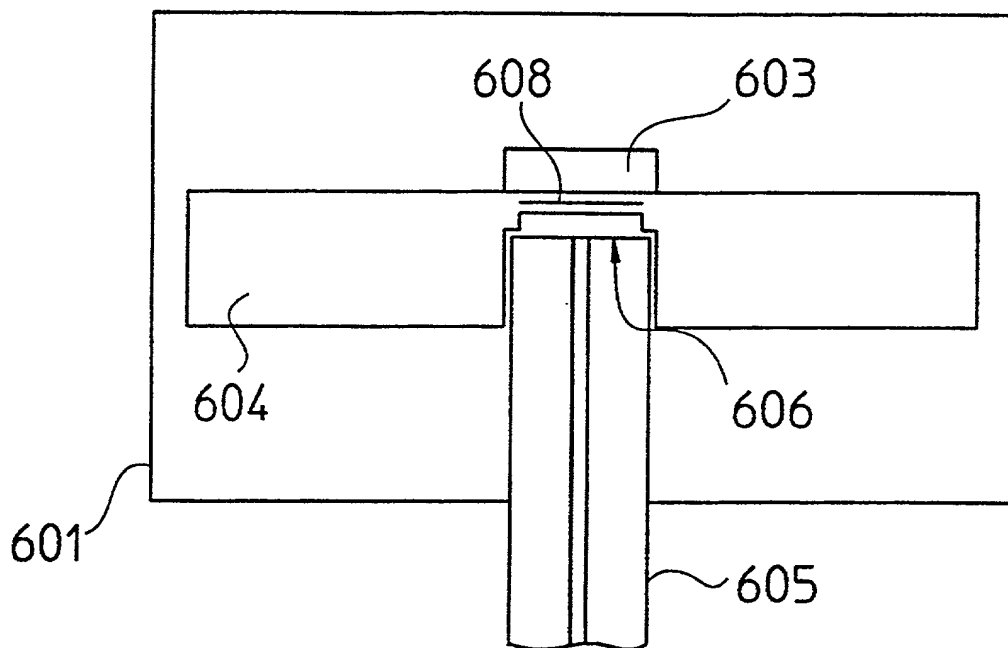


FIG. 6



Declaration and Power of Attorney For Patent Application

Erklärung Für Patentanmeldungen Mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen.

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

OPTOELECTRONIC TRANSCEIVER

deren Beschreibung

(zutreffendes ankreuzen)

☐ hier beigelegt ist.

☒ am January 29, 2001 unter der

Anmeldungsseriennummer 09/744,871

eingereicht wurde und am January 29, 2001 abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendweicher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

OPTOELECTRONIC TRANSCEIVER

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on January 29, 2001 as

Application Serial No. 09/744,871

and was amended on January 29, 2001.
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign applications
Priorität beansprucht

Priority Claimed

198 34 090.7 Germany 29/07/98
(Number) (Country) (Day Month/Year Filed)
(Nummer) (Land) (Tag; Monat; Jahr eingereicht)

X
Yes No
Ja Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 112 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code § 120 of any United States application(s) listed below and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

PCT/EP 99/04972 14/07/99
(Application Serial No.) (Filing Date)
(Anmeldesenennummer) (Anmeldedatum)

Completed Completed
(Status) (Status)
(patentiert, anhängig, aufgegeben) (patented, pending, abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001. Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden können, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

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(Name und Registrationsnummer anführen)

See Attached Exhibit "A"

John C. Freeman (312) 321-4262

Telefongespräche bitte richten an:
(Name und Telefonnummer)

Postanschrift:
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P.O. Box 10395
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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

See Attached Exhibit "A"

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Direct Telephone Calls to: (name and telephone number)

Send Correspondence to:
Brinks Hofer Gilson & Lione
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Voller Name des einzigen oder ursprünglichen Erfinders: Christian Eisenberger		Full name of sole or first inventor: Christian Eisenberger	
Unterschrift des Erfinders	Datum	Inventor's signature 6/25/2001 Christian Eisenberger	Date
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Staatsangehörigkeit Germany		Citizenship Germany	
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Voller Name des zweiten Miterfinders (falls zutreffend) Herbert Pronold		Full name of second joint inventor, if any Herbert Pronold	
Unterschrift des Erfinders	Datum	Second Inventor's signature Herbert Pronold	Date 6/25/2001
Wohnsitz D-83301 Traunreut, Germany		Residence D-83301 Traunreut, Germany DEX	
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Voller Name des einzigen oder ursprünglichen Miterfinders (falls zutreffend) <u>Peter Speckbacher</u>		Full name of the third inventor, if any: Peter Speckbacher	
Unterschrift des Erfinders	Datum	Inventor's signature <i>Peter Speckbacher</i>	Date 6/25/2001
Wohnsitz D-84558 Kirchweidach, Germany		Residence D-84558 Kirchweidach, Germany	
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Inventor(s): Christian Eisenberger, Herbert Pronold, Peter SpeckbacherTitle: OPTOELECTRONIC TRANSCEIVER**"Exhibit A"****POWER OF ATTORNEY**

The specification of the above-identified patent application:



is attached hereto

was filed on January 29, 2001 as application Serial No. 09/744,871.

I hereby revoke all previously granted powers of attorney in the above-identified patent application and appoint the following attorneys to prosecute said patent application and to transact all business in the Patent and Trademark Office connected therewith:

William A. Webb (28,277)
John C. Freeman (34,483)

Please address all correspondence and telephone calls to John C. Freeman in care of:

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The undersigned hereby authorizes the U.S. attorneys named herein to accept and follow instructions from _____ as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorneys named herein will be so notified by the undersigned.

Christian Eisenberger
Inventor: Christian Eisenberger

Date: 6/25/2001

Herbert Pronold
Inventor: Herbert Pronold

Date: 6/25/2001

Peter Speckbacher
Inventor: Peter Speckbacher

Date: 6/25/2001